Ford hybrid electric vehicle designed to achieve up to 80 mpg

HEV Uses State-of-the-Art DIATA Diesel Engine

Challenge

The Partnership for a New Generation of Vehicles (PNGV) Program, a consortium of the U.S. Department of Energy (DOE), seven other federal agencies, and the three major U.S. automotive manufacturers, are collaborating to develop highly fuel efficient vehicles. A major PNGV goal is to develop production-prototype mid-size family sedans that achieve up to 80 miles per gallon by 2004. One of PNGV's efforts focused on hybrid electric vehicles (HEVs), which require breakthrough innovations in engine technology. Engines used in HEVs must meet aggressive performance, fuel economy, and emissions targets in a commercially viable design that will appeal to the North American public.

1.2L all aluminum direct-injection diesel engine.

Technology Description

Ford Motor Company and its supplier, FEV Engine Technology, Inc., developed a 1.2-liter, direct-injection diesel engine dubbed the DIATA (direct injection aluminum through-bolt assembly) under PNGV. This high-speed, direct-injection diesel engine is the prime mover in advanced hybrid propulsion systems used in the two Ford concept cars (the P2000 and the Prodigy). The DIATA is also well suited to conventional vehicles.

The engine block uses lightweight cast aluminum to minimize total vehicle weight and thus improve fuel economy. The through-bolt design, using long bolts that bridge the entire engine block, ensures structural integrity of the block by placing the structure in compression and minimizing tensile stresses that could damage susceptible aluminum alloys under high diesel firing pressures. The through-bolt design also helps reduce noise, vibration, and harshness (NVH), which are further minimized by the crankcase structural design. Other innovative features of the engine block include 1) a cross-flow cooling system design for more uniform temperature distribution around all cylinders, and 2) formed-in-place gaskets that reduce sealing tolerances and add structural strength.

The cylinder head design uses a tandem arrangement of intake and exhaust ports coupled to vertical 4-valve assemblies that are operated by a camshaft. The camshaft is integrated into a ladder frame, adding bending stiffness to the cylinder head. The engine uses a high-pressure, common rail fuel injection system and a variable nozzle turbocharger matched to the small 1.2-liter engine size. To reduce nitrogen oxides (NO_x) emissions, cooled exhaust gas recirculation is employed.

Contact

Rogelio Sullivan
Manager, Propulsion System Development
202-586-8042
202-586-1600 fax
rogelio.sullivan@ee.doe.gov

Accomplishments

The 1.2-liter DIATA engine generates 55 kilowatts and has a thermal efficiency greater than 40% (35% more efficient than gasoline engines). The DIATA engine runs more quietly across all engine speeds than most current production direct-injection diesel engines and is comparable to current production gasoline engines. These accomplishments were delivered in record time, due to the use of advanced design tools and the fast-track development program.

Ford Motor Company has incorporated the 1.2-liter DIATA engine into its PNGV 2000 concept car, the Prodigy. This technology demonstration vehicle incorporates many other body and chassis advances that help it to achieve over 70 mpg.

Benefits

- The all-aluminum construction reduces weight and improves internal temperature uniformity, allowing an HEV to achieve aggressive fuel economy targets.
- This initiative will produce a diesel engine with an NVH profile comparable to gasoline engines that will appeal to the motoring public.
- The high-pressure, common rail system provides for extremely high power density, greater efficiency, and reduced emissions.
- The advanced concepts employed in the DIATA engine design can be applied to conventional vehicles of all types.

Future Activities

Additional research and development, aimed at further reducing engine emissions, is being conducted by DOE under the CIDI Combustion and Emission Control Program. Because of its design, the DIATA provides an ideal test bed for developing and evaluating advanced emission control systems.

Partners in Success

- FEV Engine Technology, Inc.
- Ford Motor Company